Assignment 5

Deliver the work in **ALL** MATLAB, R, and Python with randomly generated data. You should decide the parameters on your own (In MATLAB, **DO NOT** use high level functions such as frontcon, frontopt, and portcons).

1. (1.5 points) Write code that maximizes ratio of excess return to portfolio volatility (tangency portfolio)

    a. (1 points) The objective function

$$max \quad \frac{\boldsymbol{\mu}' w - r_f}{\sqrt{w' \sum w}}$$

    b. (0.5 point) Plot the tangency portfolio, minimal variance portfolio, and the efficient frontier. The tangency portfolio and the minimal variance portfolio should be recognizable on the frontier. Plot the Capital Market Line (CML)

2. (1.5 points) Write code that maximizes the trade-off between risk and expected return (you set the risk-aversion coefficient λ)

    a. (1 points) The objective function

$$max \quad \boldsymbol{\mu}' w - \lambda w' \sum w$$

    With the constraints

$$\boldsymbol{\omega}' \boldsymbol{w} = \mathbf{1}$$

    b. (0.5 point) Plot the portfolio on the efficient frontier, and the efficient frontier. The portfolio should be recognizable on the frontier

3. (2 points) Write code that minimizes a function of relative returns vs a benchmark portfolio w_{bm} (you set the vector w_{bm}) (tracking portfolio)

    a. (1 points) The objective function

$$min\, Var\left(\tilde{r}_p - \tilde{\boldsymbol{r}}' \boldsymbol{w_{bm}}\right)$$

    With the constraints

$$\boldsymbol{\omega}' \boldsymbol{w} = \mathbf{1}$$
$$\boldsymbol{w} \geq \boldsymbol{w^{min}}$$
$$\boldsymbol{w} \leq \boldsymbol{w^{max}}$$

b. (1 point) Plot the portfolio on the efficient frontier, and the efficient frontier. The portfolio should be recognizable on the frontier

Note: Any question should have all the languages to get credits. A Word document <u>MUST</u> accompany the code to <u>FULLY</u> explain your work (derivation, code explanation, result, and result comment).